Space Weather Technical Forecast

Issued on Tuesday, 09 January 2024 at 12:53 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-flares.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Low activity with peak flare C5.7 at 08/1550 UTC from AR3538, and a number of other small C-flares from across the disc. There are twelve sunspot regions, dominated by two clusters. In the western disc, previously active AR3536 remains an elongated spot but continues its slow decay, with a simplifying magnetic structure. AR3538 in the far northwest has been growing of late, perhaps developing a weak delta spot. Nearby AR3539 has also grown, whilst the other regions in this area appear stable or in decay. The other cluster consists of two sunspots close together in the southeast, AR3940 and AR3941, both of which are showing little change, and overall also remain relatively simple. A single large region has rotated onto the southeastern hemisphere, currently appearing as a simple unipolar spot. This may be part of a more complex region yet to rotate on, but currently this cannot be deduced with available imagery. No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR and ACE at L1, showed a weak enhancement likely due to a transient CME or perhaps a weak connection to CH89. Wind speeds were at background levels, but jumped from around 320 km/s to near 400 km/s. Density has been average or below throughout. Interplanetary magnetic field (IMF) has been mostly weak but with a couple of brief moderate peaks around 8nT. The north-south component has varied weakly between +/-6 nT. Phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux continued to gradually decline towards background. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was well below Active throughout. The 09/0000 UTC observation was 2.81e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: There is an ongoing chance of isolated M-flares, with a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are two potential glancing CME impacts, one from 05 Jan, arriving day 1 (09 Jan) and another from 06 Jan, arriving later day 1 or day 2 (09-10 Jan), however these are both low confidence. Otherwise some interaction with the fast wind of CH89/+ remains possible day 1 (09 Jan), but this is likely to have only a very limited impact on observed solar winds. Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled days 1 and 2 (09-10 Jan), with a chance of Active, in association with any CME or HSS arrival.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to continue declining towards background through the period, but with a slight chance of seeing further increases towards the S1 minor radiation storm threshold given any notable flaring. The high energy electron flux is forecast to remain at mainly background with no notable enhancements

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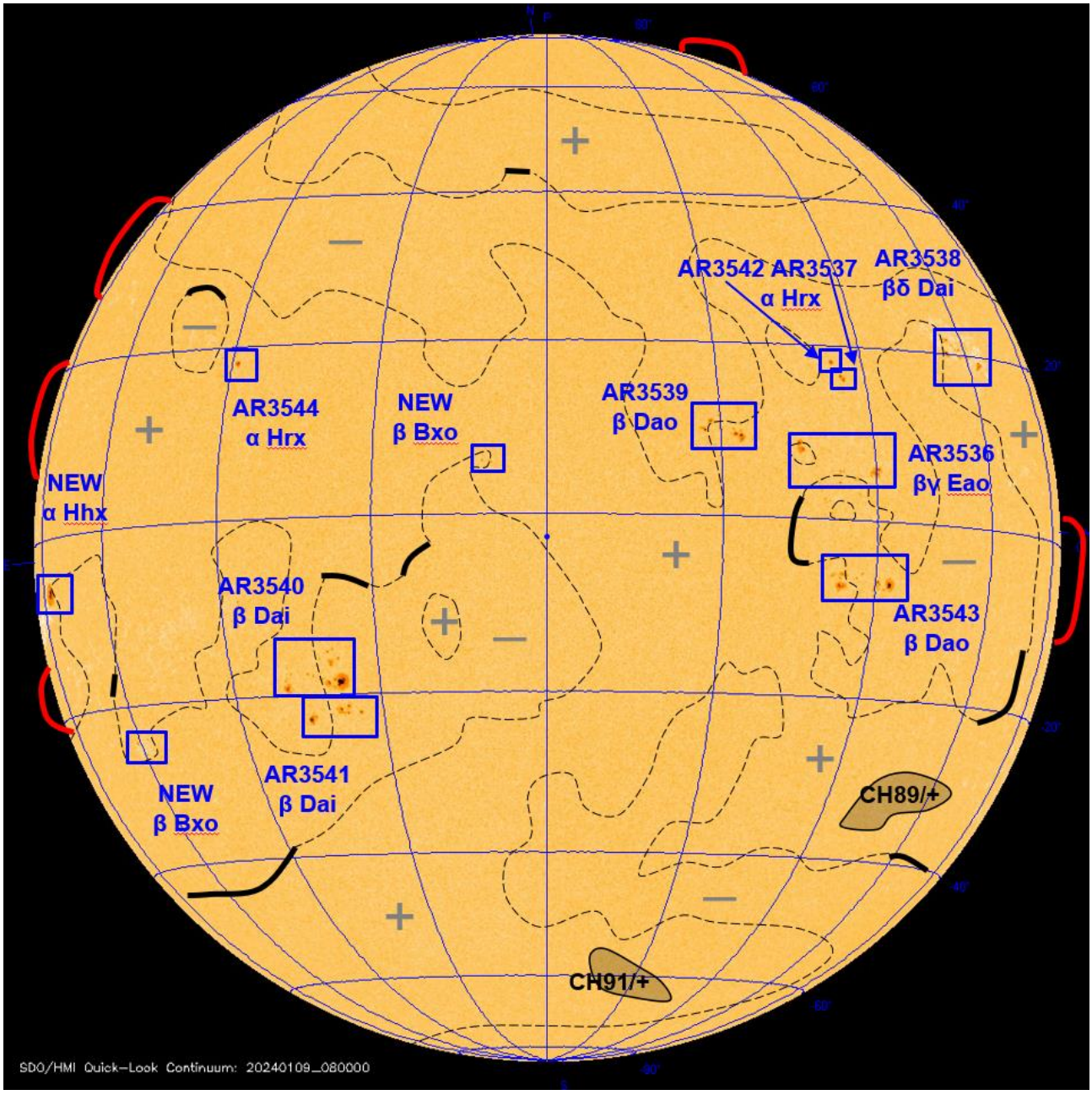
expected, and the associated 24 hour electron fluence persisting below the Active (1e8) threshold.

Figure 1. Solar Analysis Valid 09/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
There are two CMEs with potential for Earth-directed components. The first from the northeastern quadrant on 05 January (but directed southeastward) is forecast to perhaps glance the Earth early day 1 (09 Jan). Secondly, a filament eruption CME on 06 Jan probably passes close to Earth late day 1 or early day 2 (09-10 January) with the potential for a very slight glancing blow, albeit with very low confidence.

Slow winds have persisted at Earth, contrary to current MOSWOC Enlil expectations which would have Earth within a declining fast wind from CH89/+, around 500km/s. While some connection to this feature remains possible, it is perhaps now more likely that Earth is north of any fast wind that emanates from this coronal hole. Overall, peak winds of around 400-450km/s are possible day 1 (09 Jan) before easing back to background.

Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled with a chance of Active, with any fast wind or CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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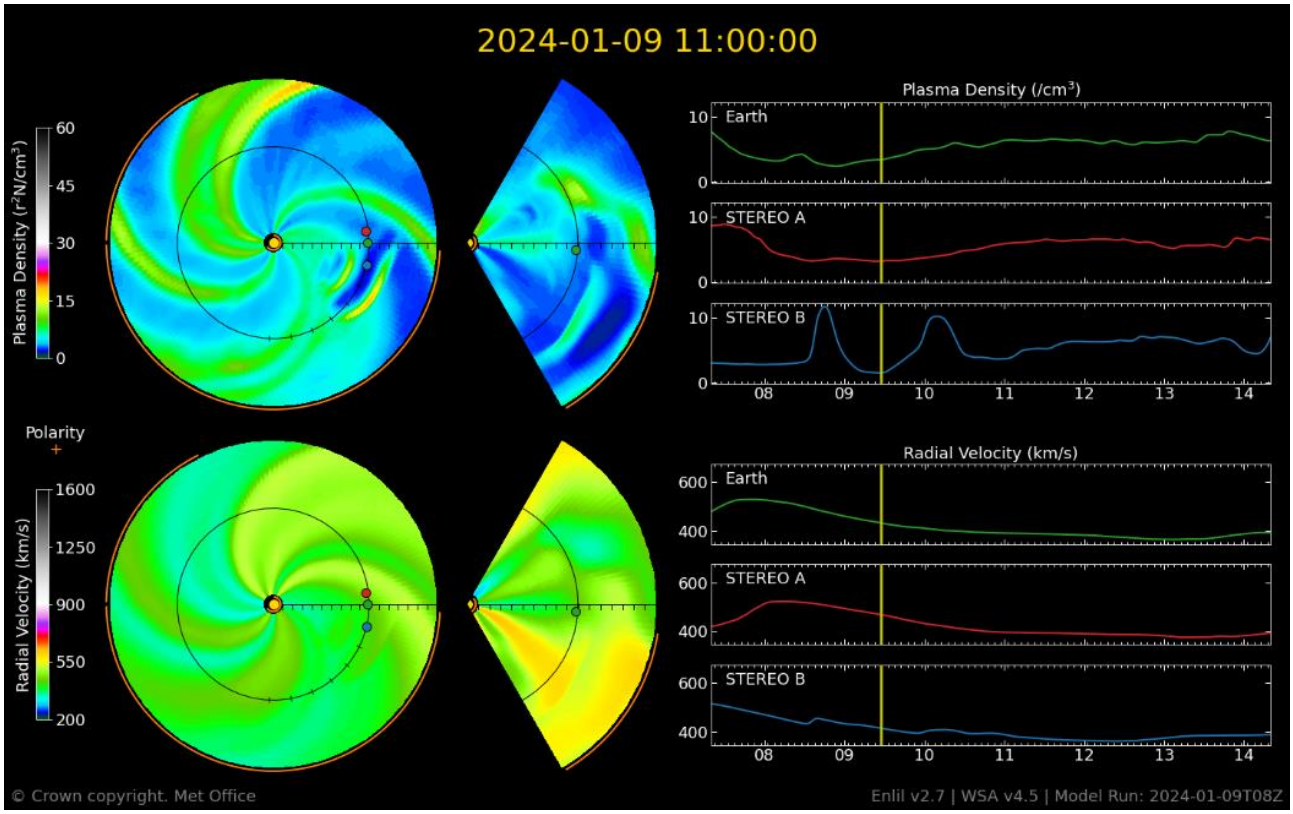
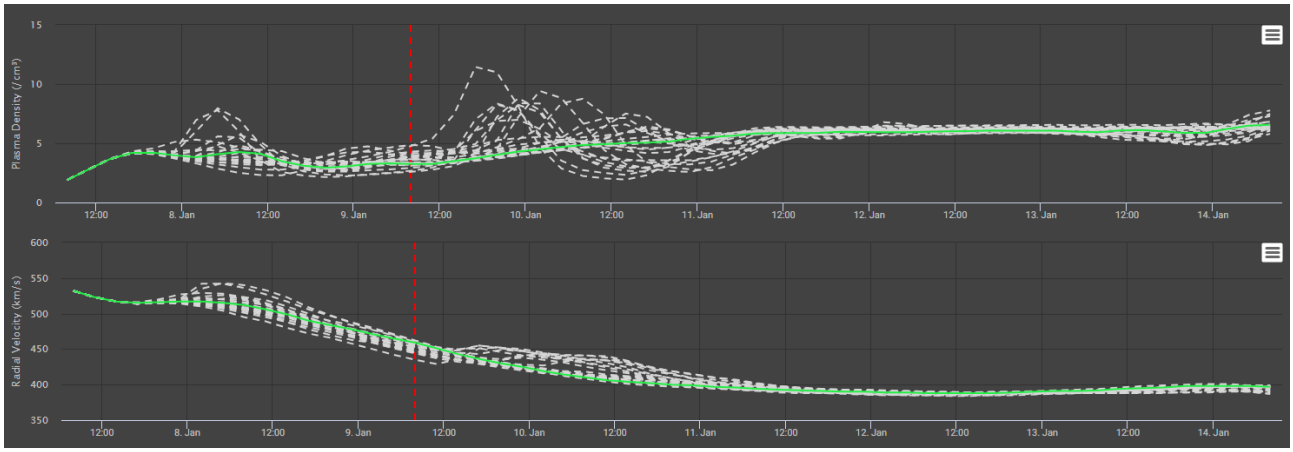
Figure 2: MOSWOC Enlil and ensemble showing a couple of potential CME glancing blows in the next 24 hours. Enlil is currently too fast with the wind speed, showing stronger connection to CH89 than we are actually experiencing.





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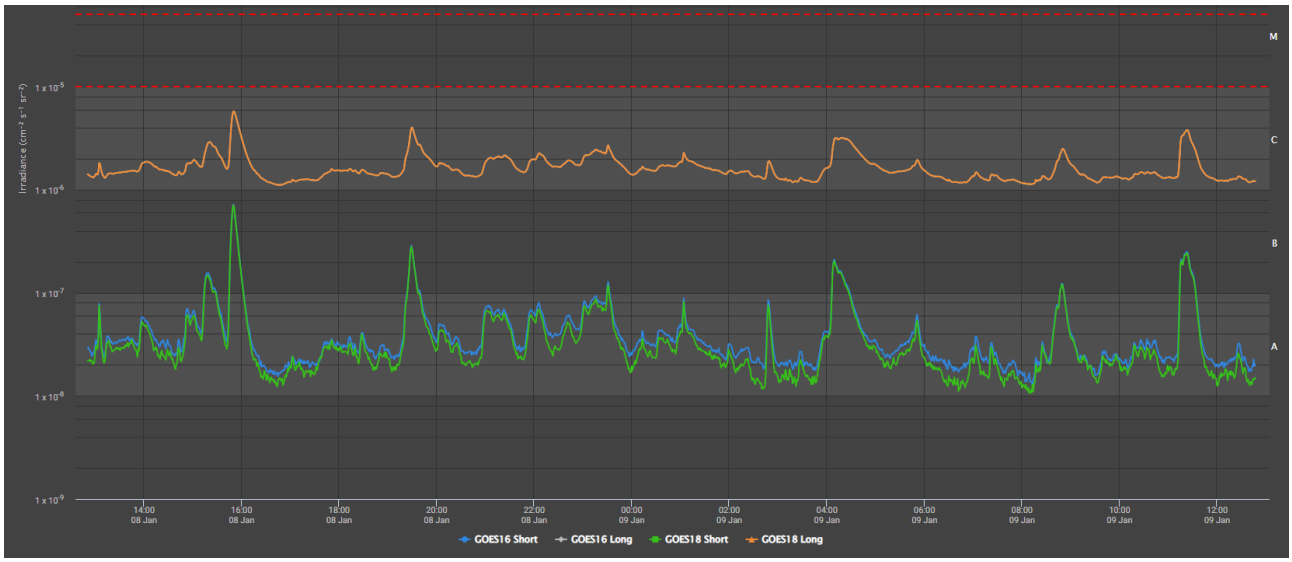
Radio Blackouts - X-Ray Flares:
There are currently twelve sunspot regions, dominated by two clusters. In the western disc, previously active AR3536 (Eao/Beta-Gamma) remains an elongated spot but continues its slow decay, with a simple magnetic structure. AR3538 (Dai/Beta-Delta) in the far northwest has been growing of late, perhaps developing a weak delta spot. Nearby AR3539 (Dao/Beta) has also grown, whilst the other regions in this area appear stable or in decay. The other cluster consists of two sunspots close together in the southeast, AR3940 and AR3941 (both Dai/Beta), both of which are showing little change, and overall also remain relatively simple. A single large region has rotated onto the southeastern hemisphere, currently appearing as a simple unipolar spot. This may be part of a more complex region yet to rotate on, but currently this cannot be deduced with available imagery. There are two further new regions which have developed, one of which is very faint but the other in the southeast is a little stronger.

Low to Moderate activity is expected, given the number of spots on the disc, along with potential for further regions to rotate on, leading to a cumulative chance of an isolated M-flare and a slight chance of an X-class flare. AR3538 is due to rotate off the disc later on Day 3 (11 Jan), leading to a very slight decline in risk by Day 4 (12 Jan).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	45
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: X-ray flares at GOES16 and 18, showing only C-class flares in the last 24 hours.



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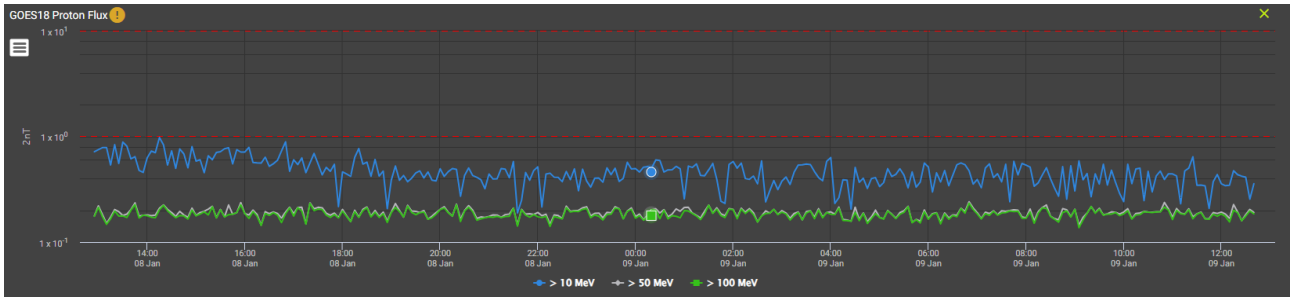
Solar Radiation Storms - (High Energy Protons):
GOES18 high energy (greater than 10MeV) proton flux is currently slightly above background, due to the ongoing effects of the Dec 31 X5.0 flare, and expected to continue to gradually ease. With a number of sunspots on the visible disc, and a large number in the western hemisphere, any further notable flares will also bring a risk of proton flux rising. There is a slight chance of reaching the S1 Minor Radiation Storm threshold.

Please note: GOES-18 is currently being used as the primary proton instrument, with GOES-16 data currently unreliable due to a fault reported by NOAA.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 10MeV proton flux at GOES18 is a little raised above background levels, but well below the S1/Minor Storm level.



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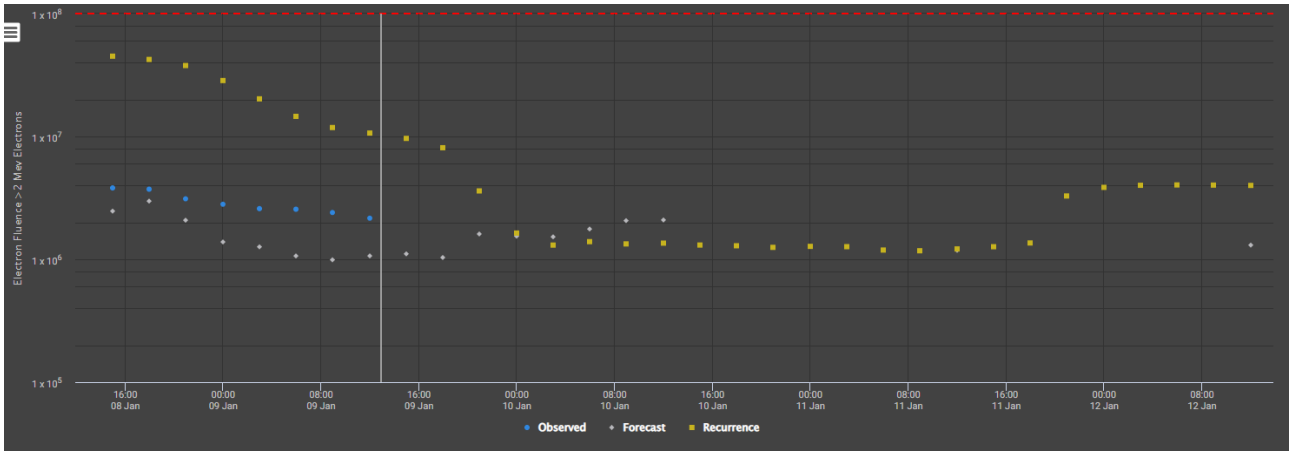
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) as measured by GOES-16 at GEO is currently at background, and in the absence of any significant enhancement is expected to persist at this level. Although brief periods of Moderate flux are possible days 2-4 (10-12 Jan) in response to any fast wind or CME enhancements that might occur.

The associated 24 hour fluence is expected to remain below the Active threshold, with REFM providing good guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM showing a below Active forecast, which seems like good guidance at this time.



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